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OZONE MEASUREMENTS FROM A STABLE PLATFORM NEAR THE STRATOPAUSE LEVEL

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WHITE SANDS MISSILE RANGE, NEW MEXICO

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ABSTRACT

The rocket-borne ozonesonde developed at the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, was modified and launched on a 28 million cubic foot balloon, along with other sensors, at sunrise on 11 September 1968. The data received as the balloon floated near the stratopause level show a concentration of ozone which is one order of magnitude more than the concentration of ozone which has been measured by spectrometric methods. The marked increase in the ozone concentration observed immediately after sunset at the 40 km level is of great significance to an understanding of the photochemistry of ozone.

CONTENTS

INTRODUCTION

The electrochemical ozonesonde developed by Brewer (1960) and chemiluminescent ozonesonde developed by Regener (1964) are regularly carried aloft on balloons to monitor the ozone concentration up to the 30-35 km altitude level. Observations above this level are very sporadic. Recently, a rocket-borne ozonesonde was developed (Randhawa, 1967) which is capable of monitoring the ozone concentration from 65 km altitude to the tropopause level. Ozone is detected by the chemiluminescence process as the instrument floats downward on a parachute.

This rocket-borne ozonesonde was modified to include a constant-volume sampling pump and launched at sunrise, along with other sensors, on a 28 million cubic foot balloon from White Sands Missile Range on 11 September 1968.

INSTRUMENT

A constant-volume sampling pump, made from Teflon, replaced the reservoir incorporated in the self-pumping feature of the rocket-borne ozonesonde. As in earlier models the inlet channel was made out of black plexiglass. A line drawing of the instrument is shown in Figure 1. The power supply and telemetry system were common to all the sensors which were mounted on a hexagonal frame, with the battery pack in the center. The ozonesonde was insulated with plastic foam because of the low temperatures (-60°C) to which it would be subjected during balloon ascent. The data from the ozonesonde were transmitted on a 1680 MHz carrier frequency on a time-shared basis with the other sensors, providing one minute of data every five minutes during a time extending from 0830 to 1949 MST.

EXPERIMENT

The balloon was launched at 0600 MST from Pony Site, White Sands Missile Range, and reached a peak altitude of 49 km after two and a half hours. Figure 2 shows the instrument package and the balloon just before the release. As the instrument passed through the tropopause, its high voltage power supply was affected by the extremely low temperatures to which it was subjected, and some initial ozone data were lost; the power supply resumed operation as it came out of the cold region. The balloon floated for about four hours at an essentially constant altitude (48.5 km) and then began losing altitude. Data were received continuously until 1949 MST

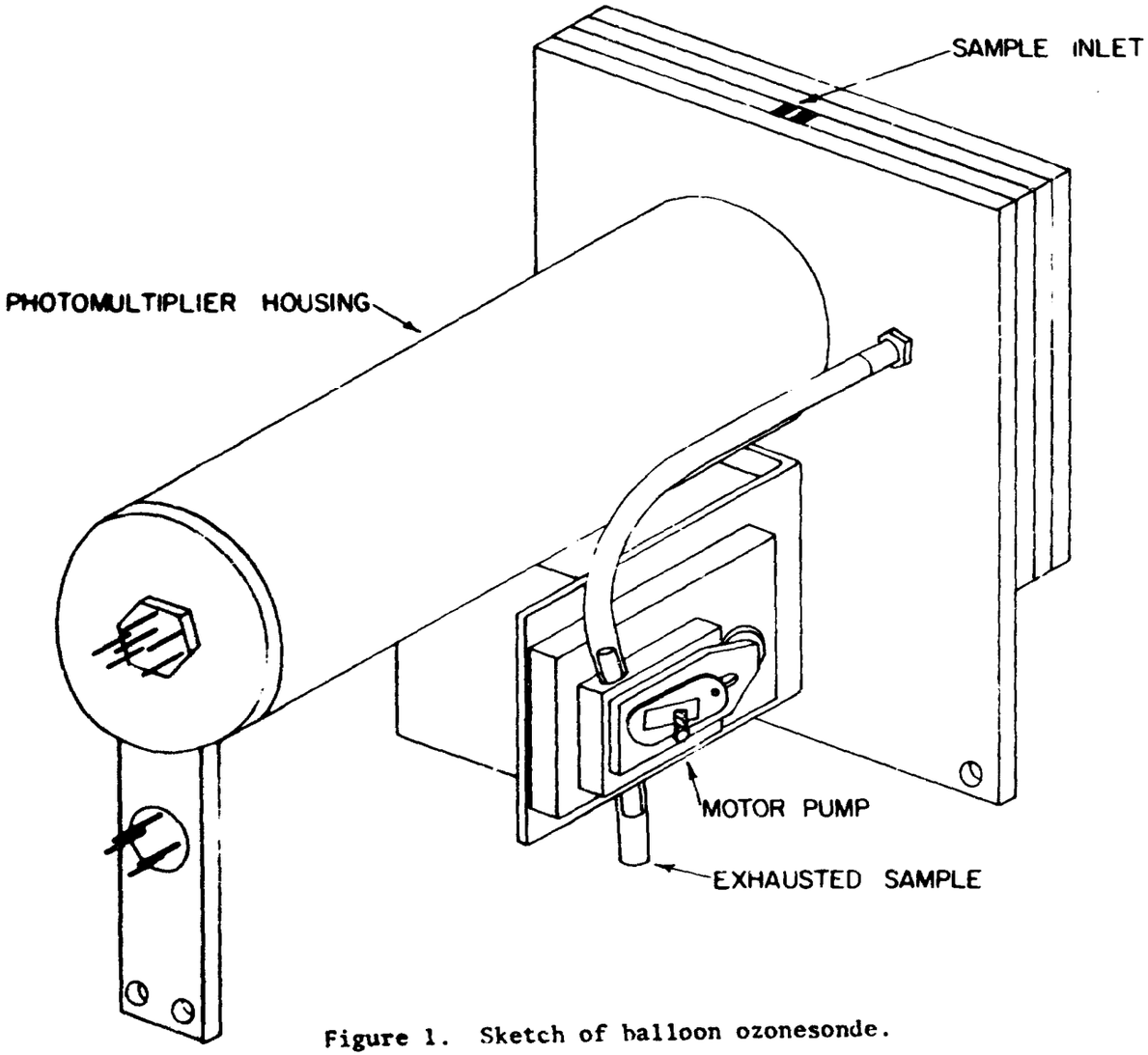

Figure 1. Sketch of balloon ozonesonde.

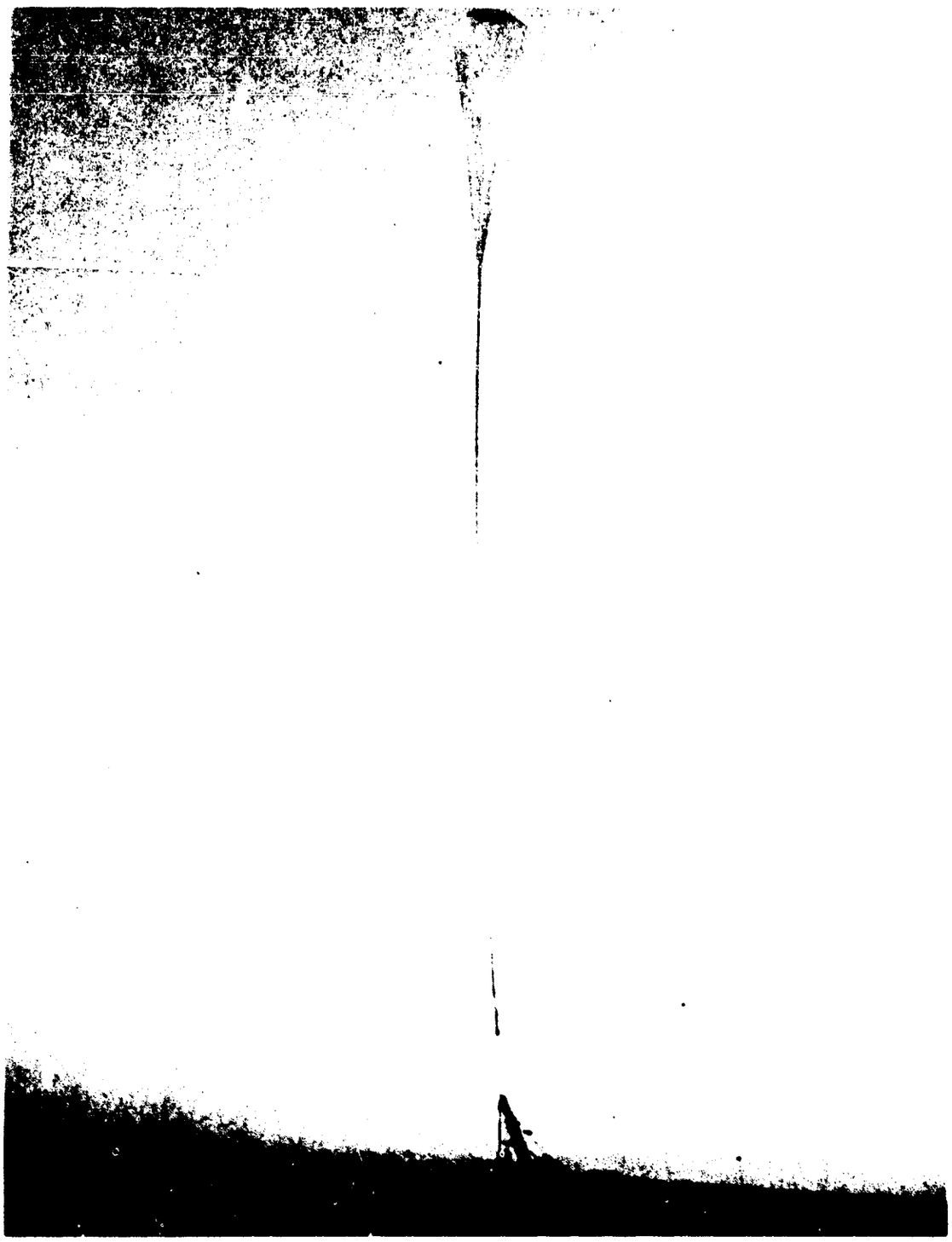

Figure 2. The instrument package and the balloon just prior to release.

at which time the balloon was at an altitude of 38 km. After that time the ozone instrument was again affected by the low temperatures.

RESULTS AND DISCUSSION

The data received from 0830 to 1949 MST as the balloon floated from White Sands Missile Range, across Arizona, to California are presented in Figure 3. The ozone concentration measured at the constant float level (48.5 km) varied between 50 and 100 gammas ($\mu gm/m^3$) which agrees with the data obtained from rocket-borne ozonesondes at these levels (Randhawa, 1968). The concentration increased in the afternoon as the balloon descended. This increase (200 gammas) is more than can be accounted for by the change in altitude alone, and it is believed that part of the increase may be due to the increase in the path length of the solar radiation as the zenith angle increased. The photochemical time scale calculated by Leovy (1969) by including reactions with hydrogen compounds is much shorter than the time scale predicted by classical theory. This short time scale could influence the ozone concentration down to much lower altitudes than previously considered theoretically.

Sunset relative to the balloon position occurred at 1918 MST. A marked increase in the ozone concentration was observed at 1919 MST, when the balloon was at an altitude of 40 km. This was the first time a sunset-related increase in ozone has been recorded from a stable balloon platform, although diurnal ozone variations (Randhawa, 1969) have been observed with rocket-borne ozonesondes at this level. The concentration recorded at sunset from the balloon ozonesonde is one hundred percent greater than that recorded before sunset and is of the same magnitude as that recorded by rocket-borne ozonesondes and an order of magnitude more than measured previously by spectrometric methods (Johnson, et al., 1952). A 5% uncertainty is estimated in these observations. There may be an additional uncertainty in the observations after 1840 MST because the high voltage power supply of the photomultiplier was affected by the low temperatures.

CONCLUSIONS

This balloon flight indicated that there is more ozone present at the stratopause level than has been measured previously by spectrometric methods. The marked change observed at 40 km at the time of sunset is of very great significance to an understanding of the photochemistry of ozone.

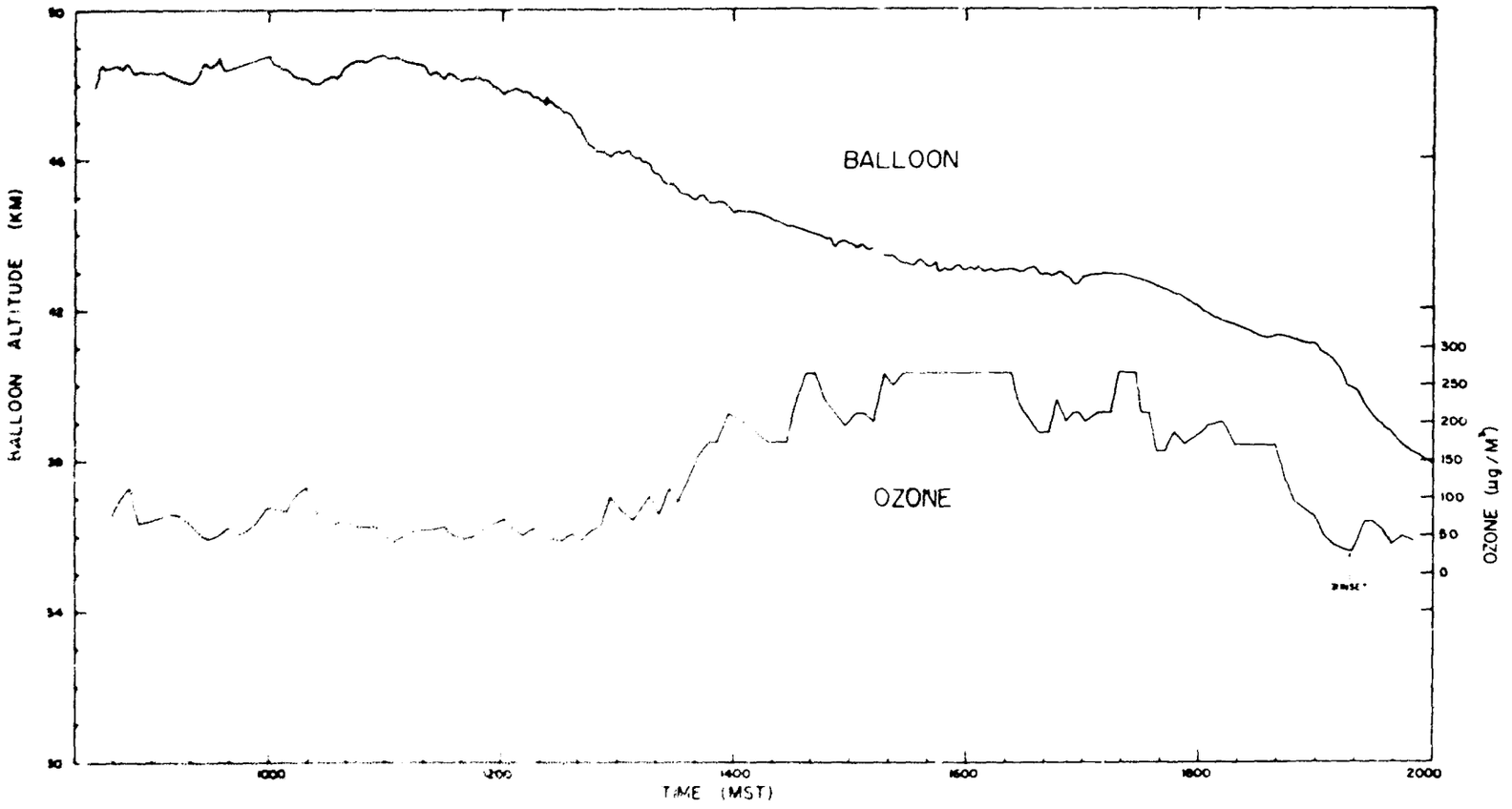

Figure 3. Ozone concentration versus altitude as the balloon floated from New Mexico to California.

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13. ABSTRACT

The rocket-borne ozonesonde developed at the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, was modified and launched on a 28 million cubic foot balloon, along with other sensors, at sunrise on 11 September 1968. The data received as the balloon floated near the stratopause level show a concentration of ozone which is one order of magnitude more than the concentration of ozone which has been measured by spectrometric methods. The marked increase in the ozone concentration observed immediately after sunset at the 40 km level is of great significance to an understanding of the photochemistry of ozone.

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